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SOME COMMON INSECT PESTS OF THE FARMER.

BY

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PREFACE.

Harrisburg, Pa., August 1, 1902.

The following bulletin No. 99, entitled "Some Common Insect Pests of the Farmer." has been prepared by Dr. H. T. Fernald, formerly Economic Zoologist in this Department.

The prevalence and destructive character of insect pests has compelled farmers and gardeners to study their habits and the means for their destruction or control. This bulletin treats of a number of varieties of insects that are most troublesome, and gives specific instructions for dealing with them.

Most of the methods suggested are quite simple, and can be employed by any careful person, who has had some experience in dealing with the fumigation of plants, the application of insecticides and the use of spraying mixtures.

JOHN HAMILTON,
Secretary of Agriculture.

LETTER OF TRANSMITTAL.

Hatch Experiment Station,

Amherst, Mass., July 10, 1902.

Hon. John Hamilton, *Secretary of Agriculture, Harrisburg, Pa.:*

Dear Sir: In accordance with your request, I submit herewith the copy for a bulletin on various insects which are causing much injury and loss to farmers and fruit-growers in Pennsylvania. Most of the insects herein treated have been written about before in previous publications of the Department, but recent and more thorough study has, in nearly every case, thrown more and better light upon the problem of their treatment, and these advances in our knowledge have been incorporated in this bulletin.

Yours respectfully,

H. T. FERNALD,

Professor of Entomology, Massachusetts Agricultural College.

SOME COMMON INSECT PESTS OF THE FARMER.

By H. T. Fernald, Ph.D., *Department of Entomology, Massachusetts Agricultural College, Amherst, Massachusetts.*

The loss to crops caused by the attacks of insect pests is rarely appreciated. A quarter of a century ago even those who studied the subject considered this loss as being about one-tenth of the total crop. To-day this is recognized as being too low and estimates of fifteen, twenty and even twenty-five per cent. are often met with. Whether the earlier estimates were too low, seems doubtful, it being more probable that the actual amount of loss has increased with the increase of continuous acreage taken by man; by the introduction of over seventy-five of the worst pests of foreign countries; and by the decrease in number of our insectivorous birds. To-day every acre tilled, every fruit tree, every vine and every stalk of grass contributes of its substance for the sustenance of insects, and it is probable that before many years pass, every crop must be so treated as to prevent loss by their ravages, if any profit whatever is to be obtained.

Some of the most frequent and seriously injurious insects with which farmers in Pennsylvania meet are considered in this paper, and, in order to combat these insects intelligently, a knowledge of their lives is necessary; hence a brief outline of the life history is given in each case, in addition to the methods of treatment most generally found to be successful.

THE HESSIAN FLY.

(Cecidomyia destructor Say.)

The Hessian Fly is an insect which causes great loss to the wheat crop in Pennsylvania as well as in all the wheat raising States. This loss varies in amount from year to year; but is always considerable and may be as much as three-quarters of the entire crop.

Life History.

There are two broods of this insect each year. The adult flies usually appear in August and September and lay their eggs on the leaves of the little wheat plants, placing from one to twenty-five or thirty eggs on a leaf and laying from one hundred to one hundred and fifty eggs in all (Fig. 1, F.). The eggs are very small, reddish, oval in outline (Fig. 1, C.), and usually hatch in four or five days, producing tiny white maggots which crawl down the leaf to the stem, then down between the stem and leaf sheath to the joint near the level of the ground. Here they remain, sucking the sap until cold weather comes, by which time they will have become about an eighth of an inch long (Fig. 1, D.). They then turn brown and become the well-known "flax seeds" so common in wheat fields during the winter. In this condition (Fig. 1, E.) they remain till spring when changes inside the "flax seed" produce the fly which escapes to lay eggs for the second or spring brood.

The eggs of this brood are laid as before on the leaves of the wheat but usually higher than those laid in the fall, so that the maggots which hatch from these eggs lie above the ground level, just above the lower joints. Here they remain feeding for about a month, then enter the "flax seed" stage, from which the adult flies appear in August and September to lay their eggs on the young wheat plants which have newly come up.

The adult fly is about the size of a mosquito, with dusky wings (Fig. 1, A, B. F.).

Food Plants.

The favorite food plant of the Hessian Fly is wheat, though it also attacks rye and barley. In some cases it has been reported as working in hay fields, but this is probably incorrect. Winter wheat on which the maggots are feeding has much darker colored leaves than plants unaffected, and tends to stool out freely causing the plants at first to appear particularly healthy. Later, however, the plants turn yellowish and die either in part or entirely. Injury to plants in the spring is chiefly shown by a weakening of the stems and an at least partial failure of the grain on the affected stalks to fill out. The laterals—tillers—which escaped the attacks of the fall brood are usually the ones injured by the spring brood.

Enemies.

There are several insects which prey upon the Hessian Fly. Unfortunately, they cannot be relied upon to protect the wheat, but only to somewhat reduce the loss, and methods for checking the work of the fly are also necessary.

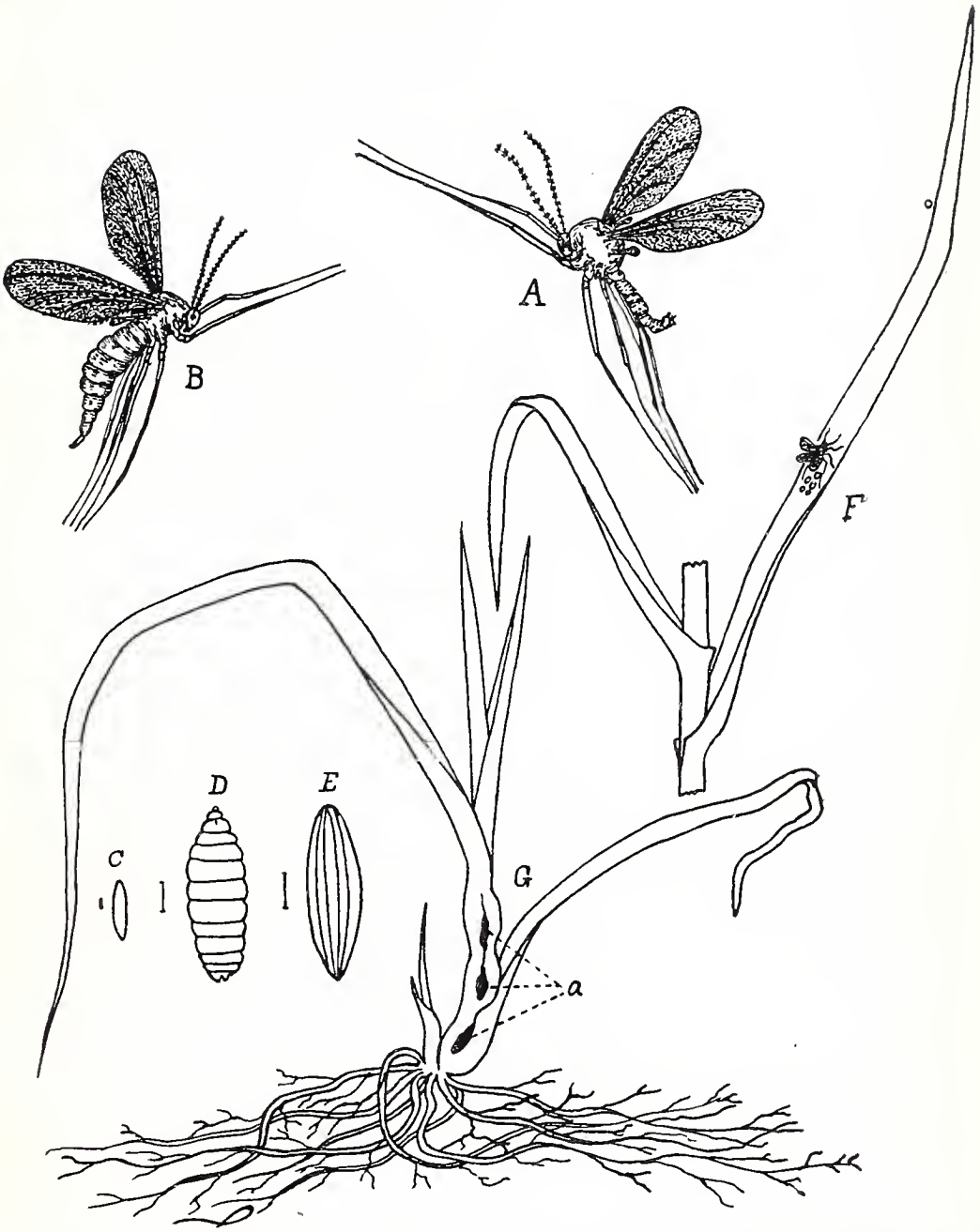

Fig. 1.—The Hessian Fly.—A, Male Hessian Fly, much enlarged; B, Female, also much enlarged; C, eggs; D, maggot; E, Flaxseed stage; F, piece of stalk showing fly natural size, laying eggs; G, stalk of wheat injured at *a*, by the fly. The fine lines beside C. D. and E. show the true length of these stages, the drawings being enlarged.—(Modified from *Riley.*)

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Treatment.

There are several ways in which the injuries caused by the Hessian Fly may be reduced, though no one of these is of itself sufficient to give entire protection.

Late fall planting is generally a method of control which is quite successful. The flies appear during the latter part of August and first of September and by the last of the latter month have died. If the wheat be planted as late as the twentieth of September, therefore, the flies will be gone before it has come up and no eggs will be laid upon it in most cases. Unfortunately, however, this date is not a fixed one for different latitudes and elevations. In southeastern Pennsylvania it might be necessary to delay planting for a week or more after this date, while in the higher lands of the northern parts of the State sowing could perhaps begin as early as the tenth of the month with success.

The fear that wheat sown as late as the twentieth of September will suffer the following winter is practically groundless, as a large amount of growth is unnecessary, for the above ground portions are mostly destroyed in any case.

One factor bearing on the date at which wheat should be sown to escape the attacks of the fly, is that of the weather conditions. A hot, dry August seems to delay the fall brood of this insect, which accordingly appears later than usual and is able to attack the late sown wheat. This was noticeably the case in Pennsylvania in the fall of 1900, and in some cases at least, threw discredit on the plan of late planting.

If sowing after the twentieth of September be practiced, it is quite important to have co-operation with all wheat-growing neighbors. If ten or a dozen wheat-growers should agree to plant late, and one should refuse, the fly will find abundant opportunity to lay its eggs on the wheat of the latter and thus produce a supply of insects which will, the following spring, spread to the surrounding wheat fields and lay their eggs for the spring brood, thus rendering late planting the previous fall a failure, at least in part.

A trap strip of wheat planted early in August is an excellent, but too seldom used, method for controlling this insect in connection with late planting. Such a small strip sown along one side of the field which is to be planted later will be available for the flies to lay their eggs on, and after egg laying has been accomplished the flies very soon die, or if they should live would of course no longer be dangerous to the main crop. This trap strip should be plowed under before the wheat in the field comes up, thus destroying multitudes of the young.

Burning the stubble soon after reaping is a valuable treatment, as

the spring brood of the fly develops at the lower joints of the wheat and a great many "flax seeds" of this brood will be left in the field at harvesting time. Turning the stubble under is also of value where burning it would be difficult, provided the ground be then rolled so that the flies which come from the "flax seeds" will be unable to reach the top of the ground. Some varieties of wheat are more resistant to the attacks of the fly, than others. Among these are the Clawson, Mediterranean, Red Cap, Underhill, Dawson's Golden Chaff and Prosperity.

The destruction of volunteer wheat is important, as many flies pass the summer in such plants.

THE WHEAT-STEM MAGGOT OR WHEAT BULB WORM.

(Meromyza americana Fitch.)

The wheat-stem maggot has long been known as an enemy to wheat in Pennsylvania, but its habits and injuries so nearly resemble those of the Hessian Fly, that its work is usually supposed to be that of the latter insect by those not familiar with it.

Life History.

This insect attacks wheat, barley, oats and various grasses. The adult fly deposits its eggs on the wheat in September and October and the maggots which soon hatch crawl down to some joint near the bulb and feed upon the stalk, cutting it off. They pass the winter in the stem, become quite pupæ in April or May and the adults emerge from these pupæ early in June. These adults usually deposit eggs on the sheath of the upper leaf and the maggots which hatch from them feed on the stem near the upper joint, causing it to wither, and the heads to turn white. The adults produced from these maggots appear in July and early August and their young attack timothy, blue grass ,volunteer wheat, etc., and mature in time to produce adults which deposit their eggs in September and October, as already stated, on the young winter wheat. There are, therefore, three broods each year.

Treatment.

Little that is successful has yet been discovered in the way of treatment for this insect. Late planting is useless as the insects may lay their eggs as late as the middle of October. The summer brood is probably the best place in the life of this insect at which to attack

Fig 2.—The Wheat-stem Maggot. Adult fly above at left; injured stalks of wheat; piece of stalk split open showing maggot at work; maggot enlarged, and a parasite. Fine lines beside the figures show the true length. (From *Lugger.*)

it. This brood feeds on volunteer grain and grasses and if a trap strip of wheat were planted about the fifth of July it would provide a place for the insects to lay their eggs. This trap strip should be plowed under about the middle of August thus destroying all the insects which were in it. Whether this treatment will pay, however, can only be determined in each case by the amount of loss caused by this insect.

Fortunately, the wheat-stem maggot is not without enemies which attack it in such numbers as to prevent its injuries being far more serious than is usually the case.

THE ARMY WORM.

(Leucania unipuncta Haw.)

This well known pest preferably feeds upon grasses, and wheat, oats and corn are therefore favorite articles of food. As it is not limited to these food plants, however, it frequently is seriously de-

Fig. 3.—The Army Worm Moth, natural size.

structive to clover, peas, apples, cucumbers, barley, rye, etc. With such a range of plants to feed upon, it is fortunate that this insect is not often seriously abundant for more than a year or two at a time.

Life History.

The eggs of the Army worm are laid in the spring and the caterpillars which hatch from them become adult moths in June. These moths lay their eggs for a second brood and the caterpillars of this brood are often so abundant as to do much damage during the month of July. About the end of this month, however, the caterpillars become full grown, cease feeding, enter the ground to pupate and the moths which emerge from them appear in August and lay eggs for a third brood. The caterpillars of this brood are sometimes so

abundant as to cause much injury, but it is more usually the case that those of the second brood are the ones whose ravages are most seriously felt. The caterpillars of the third brood usually reach the moth stage before winter, but those which fail to develop so far, pass the winter in whatever condition they may happen to be and become adult the following spring. It is possible that in southern Pennsylvania a fourth brood may be able to develop, particularly in years when there is a late fall.

Injuries.

The first brood of caterpillars does but a moderate amount of damage, eating holes in the leaves. When the food available has all been eaten, the caterpillars search for more, starting off together and forming the "armies" which have given to this insect its name. This almost never occurs with the first brood, however, and only at intervals of several years with the second or third broods, the insects not being usually so abundant as to exhaust their food supply. Upon reaching food, the caterpillars begin their work and strip everything as they go, and when full grown, either under ground or among leaves and grass, become quite pupæ from which the moths subsequently emerge.

Parasites and Treatment.

The Army worm has a number of parasites which feed upon it and their activity is probably the reason why this insect is not more often a serious pest. Among its most efficient foes are two kinds of flies which occur in large numbers where the Army worm is abundant.

Parasites, however, sometimes fail to destroy enough Army worms to prevent much loss, and in such cases, treatment must be resorted to. Where a field is thoroughly infested by these pests, little can be done, but when the caterpillars begin their march for more food, an excellent practice is to plow a furrow across their line of march, throwing the earth towards the advancing army. In order to cross this furrow each caterpillar must crawl over the loose earth thrown up, then cross the bottom, and finally crawl up the steep side. At intervals of a few feet along the bottom of the furrow, holes may be dug (or bored with a post hole auger if the ground will permit) and many of the caterpillars will collect in these holes, which may with advantage be made as much as two feet deep. A band of gas tar placed along the bottom of the furrow may be used to hold the caterpillars, when it can be obtained, and sometimes straw scattered along in the furrow and set on fire when covered by the cater-

pillars has proved useful. When the army is large, two furrows a few feet apart may be needed to check its advance.

Sometimes the progress of the caterpillars can be checked by heavily spraying a strip of field at the edge they are approaching, with Paris green. The insects coming to this strip first, feed upon it and are poisoned. Care should be taken, however, in such cases, not to feed any of that part of the crop thus sprayed, to stock.

WIRE WORMS.

(Elater sp.).

The injuries caused by wire worms are frequently quite serious, and as the work of these insects is upon the roots of plants it is difficult to control them. In reality, wire worms are not adult insects, but the young of "Snapping beetles" or "Click beetles" as they are

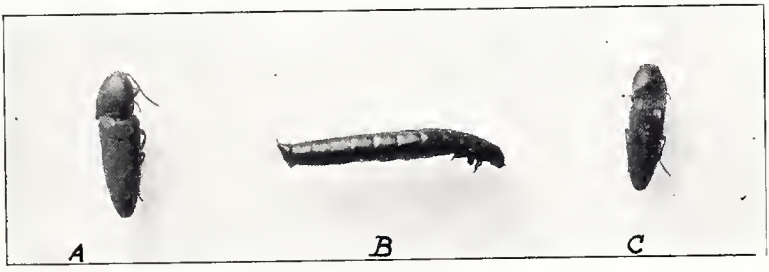

Fig. 4.—Wire Worms. B, side view of a wire worm: A and C. adult of wire worm (click-beetles).

often called, from the habit they have when placed on their backs, of suddenly "snapping" themselves in such a manner as to throw themselves into the air, when they in most cases can fall on their feet.

There are many kinds of snapping beetles in the United States and a corresponding number of kinds of wire worms, their young. A few live under the bark of trees or in decaying wood; most, however, live in the ground and feed upon seeds and the roots of various plants, often causing much loss.

Life History.

The eggs of these insects appear to be laid in the spring usually and from them the little wire worms soon hatch and begin to feed. It generally takes several years before the little wire worms have fed enough to become full grown, but when this condition has been reached each forms a little cell in the ground, during the latter part of the summer, and in this cell changes to an adult snapping beetle, which remains in the cell till the following spring.

Treatment.

Treatment for this pest is not usually possible by means of poisons though in some cases their numbers might be reduced by such methods.

Probably the best way in which to control wire worms is by late fall plowing, repeated for two or three years. This destroys the wire worms by bringing them up to the surface of the ground where exposed to the freezing and thawing of the winter, many will perish or be devoured. Breaking the cells above described appears to cause the death of the insects which occupy them, and thus fall plowing is useful for the destruction of this stage as well. Rotation of crops is unfavorable to the increase of wire worms and should also be practiced for this reason if for no other.

THE ANGOUMOIS GRAIN MOTH.

(Sitotroga cerealella Oliv.)

This insect is an important enemy to wheat and corn in Pennsylvania, often causing much loss, particularly when appearing during the fall after the attacks of the Hessian Fly have greatly reduced the amount of wheat produced.

The Angoumois grain moth has been present in this country for many years, being most injurious in the south where the longer seasons permits a greater number of broods than is possible in northern latitudes. In Europe it is also a pest and takes its name from a province of France where it has caused much loss.

Life History.

The moth of this insect is very small, about the size of the clothes moth, and yellowish in color. It appears in the spring, usually during May and June, and lays from sixty to ninety eggs. These are laid separately and if on wheat, are placed in the furrow on the side of the kernel itself, one on each grain. The little caterpillar which hatches from the egg bores into the grain and feeds upon its contents until it is full grown, this process requiring about three weeks. At the end of this time the caterpillar is about one-fifth of an inch long and little of the grain is left except an outside shell. The caterpillar now cuts a part of a circular slit in this shell, leaving just enough of the circle uncut to hold the piece in place, and then forms a

silken cocoon around itself within the grain. In this cocoon it transforms from the caterpillar to the moth and when this change has been completed the moth pushes out the circular piece cut by the caterpillar in the surface of the grain, and escapes. This usually occurs in August, and the moths therefore find themselves either in the stack, when threshing has not yet been completed, or wherever the grain has been stored. They now proceed to lay the eggs for a second brood which has a similar history. The work of this brood like that of the first is generally overlooked until the moths appear, at which time the abundance of the little "millers" around the bins and granaries, and the holes in the grains become noticeable. If the temperature of the place where the grain is stored be high enough, the moths lay their eggs for a third brood and if conditions permit will continue breeding through the winter. Usually, however, in Pennsylvania but two broods occur, and the insect passes the winter in whatever stage it happens to be when cold weather overtakes it.

Parasites and Treatment.

There are two foes to the Angoumois grain moth in Pennsylvania —a mite, and a minute insect known as *Catolaccus*. The latter has been quite abundant in this Commonwealth and has prevented some loss, but has failed to control the grain moth. Treatment should therefore be resorted to.

For the first brood of the grain moth nothing can be done as the insect is working inside the grain while it is yet uncut in the fields. After harvesting, however, the second brood can be cheaply and easily handled.

In order to successfully treat the grain at this time, it is desirable to thresh it as soon as possible after harvesting. Then when the grain has been placed in the bins it can be fumigated with carbon bisulfide and all the insects destroyed.

To properly use the carbon bisulfide the following directions should be followed: See that the bin is tight and that it can be closed so as to be fairly tight at the top, though this is less important. Place shallow dishes on the top of the grain and pour the carbon bisulfide into these; then close the bin and leave it undisturbed for twenty-four hours, after which the cover may be lifted and the bin left to air for an hour. Now stir over the grain to find if all the insects have been killed, and if any remain (which is not usually the case) repeat the treatment.

The quantity of carbon bisulfide to use depends on the size of the bin, the usual amount being one pound (costing twenty-five or thirty cents) to every thousand cubic feet contained in the bin. Thus one pound would be sufficient for a bin ten feet wide, ten feet long and

ten feet high, and the amount of grain contained in it does not matter. To advantageously use the bisulfide in a bin, it may be divided between several dishes set on top of the grain, and as it begins to pass off as a gas into the air at once, the lid should be closed as soon as the bisulfide has been placed in the dishes. The gas it forms is heavier than the air and sinks through the grain, killing all the insects it reaches.

Two precautions in using this method should be mentioned. Avoid breathing the gas as far as possible as it is very disagreeable and in sufficient amount might be injurious. Avoid using the gas near flame or much heat of any kind as it catches fire easily and a lighted pipe in the mouth of a workman close by, or a lighted lantern within a few feet of the bin during the time treatment is going on might produce serious results. No injury of any kind is caused to the grain by this fumigation, and seed wheat seems to be as good for sowing afterwards as before.

This method of fumigation is also excellent for the destruction of the pea and bean weevil and other insects, and can also be used for the destruction of insects in cereals, meal, ground tobacco, and in fact in anything which can be placed in a box or bin tight enough to prevent the escape of the fumes of the bisulfide for a period of a day or more.

THE CODLING MOTH.

(Carpocapsa pomonella Linn.).

The Codling moth is perhaps responsible for more of the loss to our apple crop than any other insect. Its caterpillar, generally called the "apple worm," begins its attack soon after the fruit forms in the spring and destroys multitudes of apples before they are more than one-third grown. These are seldom taken into consideration, only those which are wormy later in the season being noticed. But these form a large proportion of the gathered crop where no treatment for the control of this insect is carried out, and the loss in the form of second or third class, where first class fruit could otherwise be obtained, reaches millions of dollars nearly every year—a loss which is wholly unnecessary as it can in large measure be avoided.

Life History.

The Codling moth spends the winter in the caterpillar stage snugly hidden under some loose piece of bark on the trunk of the apple tree or in equally protected places near by. In April usually,

the caterpillar becomes a quiet pupa the skin of which is dark brown, and in this form remains for two or three weeks. At the end of this period the pupa opens and the adult Codling moth appears soon

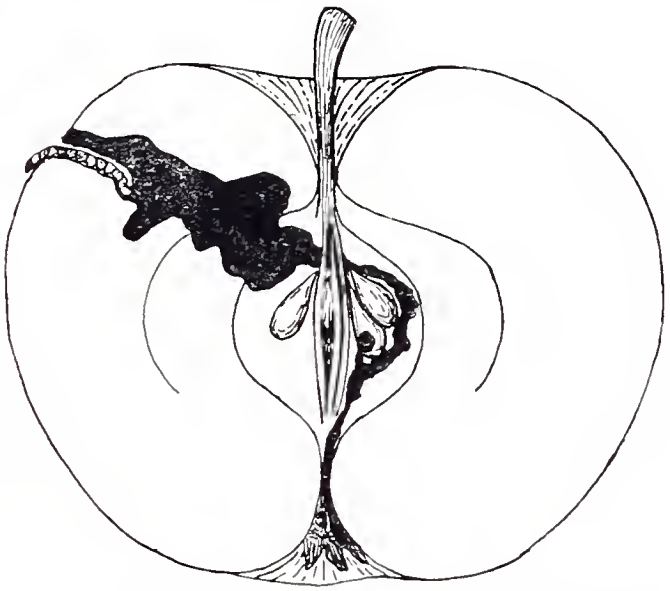

Fig. 5.—Apple, cut to show work of Codling Moth, with caterpiller leaving, at the side. Natural size.

after the apple blossoms have fallen and the fruit which has "set" is beginning to enlarge. The eggs are now laid, one in a place, on the side of the apple, on its stem, or on a twig or leaf near by, a single moth laying between fifty and a hundred eggs. These eggs hatch in about a week and the tiny caterpillars crawl to the fruit to begin feeding. Probably about eighty out of every hundred of these caterpillars enter the apple at the blossom end which now faces upward or outward, but which as the apple grows larger will turn down with it until it is beneath the apple. Here at the blossom end of the fruit the caterpillar crawls in between the five little green projections (calyx lobes) which later dry up and turn black, and begins to eat into the substance of the apple, usually working to and around the core where it feeds for nearly a month or until it is full grown. It then eats its way to the outside of the apple and leaves it to find a place in which to become a pupa. If the apple it has fed in be still on the tree, the caterpillar on leaving it will probably crawl down the trunk until it finds a piece of loose bark beneath which it can crawl. Here it gnaws out an oval hollow in the bark, lines it with silk and becomes quiet. If the apple has fallen, however, any protected place the caterpillar can find will be taken in which to form its silk cocoon. This change usually occurs during July and the caterpillar may either remain quiet until the following spring, or in some cases become a pupa from which the adult moth soon comes to lay eggs for

a second brood. It is probable that both of these alternatives occur in Pennsylvania, some of these insects having two broods each year while others have but one. In cases where there is a second brood the eggs are laid in August or September, and the caterpillars feed as is the case with the spring brood except that a much smaller proportion appear to enter the fruit at the blossom end. If the caterpillars reach full growth before the apples are gathered they leave the fruit and conceal themselves under bark or elsewhere as already described. If carried in the apples to the bin, however, they find places in which to pass the winter, in crevices of the bin, or any place which may be available, forming pupæ there in the spring, like the others.

Treatment.

From the life history above outlined the best treatments available for this insect are evident. As the majority of the caterpillars feed first at the blossom end of the apple, and as these ends face upward at this time, spraying a few days after the blossoms fall, with Paris green or arsenate of lead, will, if properly done, place a little of the poison in the blossom end between the calyx lobes, just where the caterpillars will begin to feed. This method of treatment has been successful wherever tried. One precaution is necessary however. The calyx lobes at first stand apart, making a sort of cup into which to spray the poison. After a short time, however, they draw together closing this cup and it is then too late to spray in this manner with success.

The habit the caterpillar has of crawling down the trunk of the tree and hiding under some loose piece of bark during July, also gives an opportunity for treatment. The bark of the trunk and larger limbs of each tree should be carefully scraped about the twentieth of June, to leave no places under which the caterpillar can hide. Then a band of several layers of paper loosely tied around the trunk will provide a place in which they may gather. If these bands be turned over once a week during July and the first of August, and the caterpillars destroyed, many will be prevented from becoming adult to cause loss later. Birds aid in this work, often regularly visiting these bands and feeding on the caterpillars.

Fowls in the orchard destroy many of the caterpillars which have fallen to the ground in the fruit; careful cleaning of the apple bins and other places near where apples have been stored, early in the spring, will destroy many more, and if all these methods are made use of, the increased profit from the sales will many times more than pay for the cost and labor involved.

THE APPLE-TREE TENT CATERPILLAR.

(Clisiocampa americana Harr.)

This familiar pest on our apple trees is of importance only when neglected, as its presence becomes evident at an early stage. It feeds on the cherry, plum, peach and wild cherry as well as on the apple, and its tents at once call attention to its presence whenever they appear. It should be remembered, however, that the tents of

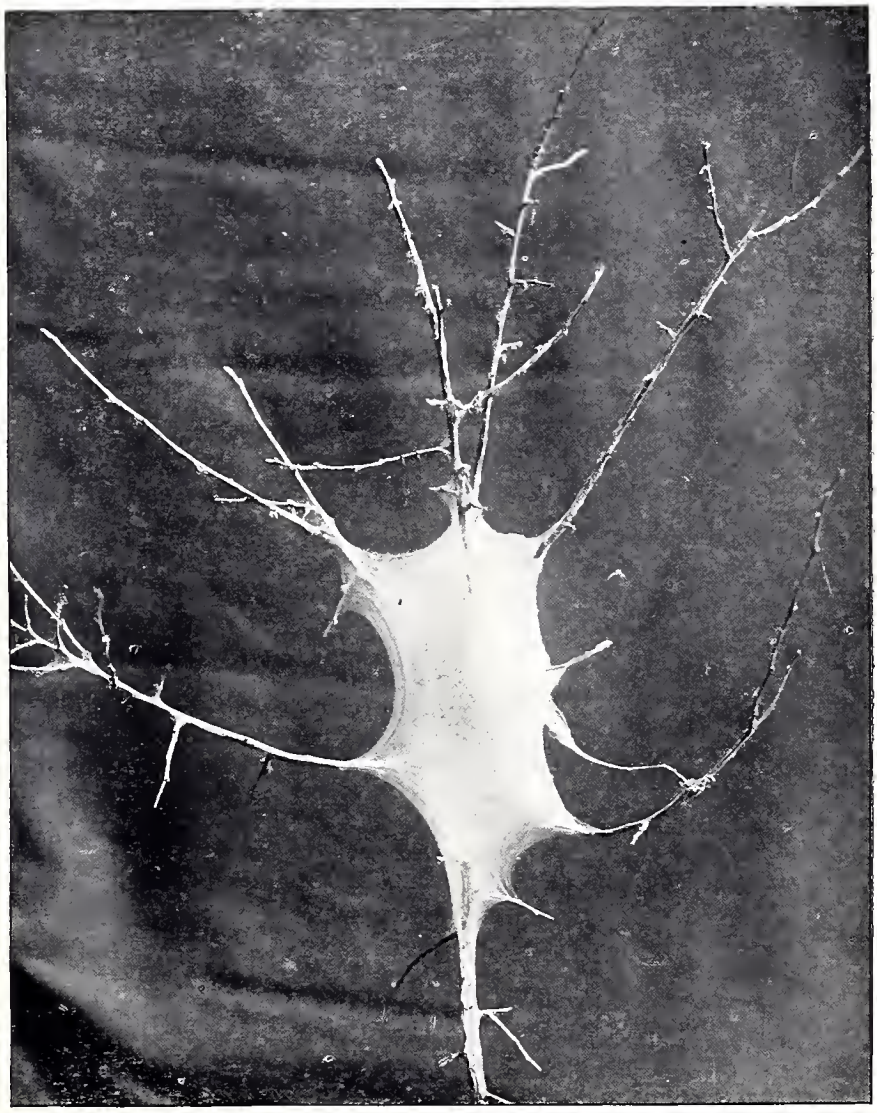

Fig. 6. -Tent of Apple-tree Tent Caterpillar. On the lower branch at the right is the egg mass from which the caterpillars hatched.

this insect appear in the spring, while similar ones which become noticeable in the summer and fall are produced by other kinds of insects.

Life History.

The eggs of the apple-tree tent caterpillar are laid in July in the form of a ring or band around some small twig, each band containing from one hundred to three hundred eggs. At the edges the band which is half an inch or more in width is beveled down to the twig. The whole band is then covered by a brownish substance which hardens and forms a sort of varnish which conceals the individual eggs beneath.

The egg bands remain on the twigs from July until the leaf buds begin to open the following spring. At about this time, however, the eggs hatch and the little caterpillars crawl to some fork near by where they spin a tent, small at first, but enlarged from time to time as the caterpillars grow. From this tent the caterpillars go to feed, mornings and afternoons, returning to it at night, and in part, at least, about noon. Most of them also stay in the tent during rainy weather.

The caterpillars feed for five or six weeks before becoming full grown. As this condition is reached, each leaves the tent to find some protected place in which to spin a loose silken cocoon, within which it transforms from the caterpillar to the adult moth, a process requiring from two to three weeks. This change having been completed the moth appears sometime in July, and the eggs are laid from which caterpillars will appear the following spring. There is therefore but one brood a year.

Injury.

The amount of injury caused by this insect varies with its abundance. A full grown caterpillar will eat about two leaves a day and one tentful will therefore consume from two to six hundred leaves in this time. Averaging this rate of food consumption for the entire time they are feeding, we find that a tent containing two hundred caterpillars will consume over four thousand leaves in all. A vigorous tree would probably feel this but little, but a small tree, or a large one with a number of tents on it would be obliged to turn its energies to the putting forth of new leaves to take the place of those lost, just at the time when those energies should be devoted to the maturing of its fruit.

Treatment.

The treatment for this insect is simple, the fact that the caterpillars return to the tents at night making it easy to destroy these when all the caterpillars are together, either by means of a torch held under the tent, or better, by crushing tent and caterpillars with a gloved

hand. In using the torch many of the insects drop to the ground and escape, while the flame is injurious to the tree—both being objections avoided by the other method. Spraying the tree with arsenate of lead or Paris green when the tents appear is also a successful treatment.

The eggs masses are often very noticeable, particularly while the trees are leafless, and should be cut off and burned, and every fruit grower should see that no tents of this insect should be permitted on the wild cherry and other trees along the roadsides near his orchards, unless he is prepared to find them present on his fruit trees the following spring, as a result. The continued presence of this insect in an orchard is evidence of neglect.

THE ROUND-HEADED APPPLE-TREE BORER.

(Saperda candida Fab.)

This insect is "next after the codling moth, the worst enemy to apple culture in America." The greater portion of its life is spent beneath the bark of the tree where it is only accessible to its enemies in a limited degree.

Fig. 7.—Round-headed Apple-tree Borer. A, Adult Beetle; B, full-grown grub Both enlarged.

Life History.

The adult beetle which is rarely seen is about three-quarters of an inch long, grayish in color, and with two white stripes along its back. It lays its eggs during June, July and August in slits in the bark, usually near the ground. The young beetles which hatch in two or three weeks after the eggs are laid, bore into the inner bark and sapwood where they feed, making shallow cavities, often so near

the surface that the bark over these cavities cracks and some of the "sawdust" falls out. During the winter the borers are quiet, but resume their work the following spring. During this second year they work deeper into the tree, boring in the heart wood, but at the approach of winter become quiet again. The next spring they bore out to the bark and then become quiet pupae for a short time, after which the adult beetle formed from the pupa during this stage gnaws through the thin layer of bark left over the hole and escapes.

Food Plants.

This borer works in the trunks of the apple, pear, quince, thorn, English hawthorn, Mountain ash, June berry and other trees.

Treatment.

To prevent this insect from laying its eggs on the tree, a wrapping of several thickness of paper may be placed closely around the trunk. The paper should be covered by a little earth at the bottom and reach up about two feet, and be closely tied, so that the beetles cannot get between it and the trunk. The wrapping should be applied about May 10th and remain at least until September

Wire window-screen netting can also be used for this purpose, care being taken that the lower edge of the netting be covered by the earth, and that some little space is left between it and the trunk except where it is fastened tightly around the tree about two feet above the ground. A protector of this kind will last for several years and if properly applied in the first place will need no attention.

Either of these methods will protect the lower part of the trunk; but as the beetle sometimes lays its eggs higher up, it is advisable to whitewash the trunk from the lowest fork down to the top of the protector at the time when this is put in place.

When borers are already in the trunk, their presence may often be discovered by the accumulation of sawdust around the base. In such cases the insects may be cut out with a knife, or if they are too far in to be conveniently reached in this way, a sharp-pointed flexible wire may be used with which to follow the hole and pierce the borer. Frequently when the burrow can be found, the most convenient treatment is to pour a little carbon bisulfide on some cotton, place the cotton in the hole and then plug up the hole outside, leaving the fumes of the gas to kill the borer.

THE PLUM CURCULIO.

(Conotrachelus nenuphar Herbst.)

The plum curculio is the cause of more loss to plum growers in this State than all other insects combined, fifty, sixty or even seventy-five per cent. of the plums often being destroyed by its attacks. Quite a part of this loss can be avoided, however, by using the proper methods, while if these are neglected the insect as it becomes more abundant in an orchard will also attack apples, pears, cherries and peaches injuring the appearance of these fruits and thus lessening their value, even when it does not prevent their reaching maturity.

Life History.

The plum curculio in its adult state is a little beetle about a quarter of an inch long, dark in color but with a few whitish markings on its roughened back, and with a snout on its head. It passes the winter hiding in any protected place it can find, and makes its appearance about the time the leaves open in the spring. While waiting for the plums to form, it feeds on the young leaves somewhat though doing little damage in this way, but when the blossoms have fallen and the plums have begun to grow, it proceeds to lay its eggs. To do this, it makes a small hole in the plum with its snout and in this hole it deposits an egg. It appears to realize, however, that unless farther precautions are taken, the rapid growth of the hard young plum will crush and destroy the egg, and it therefore cuts a crescent-shaped slit near where the egg was placed. The result of this is that the flesh of the plum between the egg and the slit wilts and remains soft, and crushing of the egg is thus prevented. Each curculio lays from fifty to one hundred eggs in this way and plums with six or eight slits and egg holes are frequently observed.

The eggs thus laid soon hatch and the young grubs eat into and around the stone, while the surface of the plum where the slits were made becomes gummy.

Around the stone the grub feeds till it is full grown, the time required for this being usually about three weeks. The grub then leaves the plum (which frequently falls off before this time, because of the presence of the grub) and enters the ground where it becomes quiet and transforms to a pupa from which the adult curculio appears a month or more later. Apparently this curculio does no injury during the remainder of the summer and fall but appears after wintering in some secluded place, to lay its eggs the following spring.

Treatment.

No one method of treatment is sufficient for this pest, but if the three given below be practiced, much loss will be prevented.

1. It has already been stated that in the spring the adult curculios feed on the young leaves until the plums have begun to grow. This fact may be taken advantage of by spraying the trees with Paris green, or better, with arsenate of lead just before the blossoms open, and repeating this treatment as soon as the blossoms have fallen. Do not spray while the trees are in blossom.

2. The adult curculios during the time they are feeding and laying their eggs, are sluggish mornings and evenings, though they will fly freely during the heat of the day and also on warm nights. This habit is successfully utilized by plum raisers who spread out sheets under the trees early in the mornings and then jar the trees by striking the trunks with a heavy mallet. The curculios fall onto the sheets and are gathered and destroyed. An improvement on this is to stretch canvas over a frame having sloping sides, and at the center opening into a tin can containing a little kerosene. A slit from the middle of one side to the center is not covered by the canvas but is left open so that the trunk of the tree may pass in through this to the center of the frame. A strip of canvas sewed to one side of the slit is then turned over to cover it and the canvas completely covers the ground under the tree. Such a frame mounted on a wheelbarrow can be conveniently and rapidly used and the curculios which fall upon the canvas when the trees are jarred, roll down the sloping sides of the frame and into the can of kerosene in the center. Plum orchards of hundreds of trees are every year treated in this way with great success, the trees being jarred every other morning.

3. The above methods will prevent multitudes of the curculios from laying a part or even any of their eggs, but it is equally important to destroy as many as possible of the grubs coming from eggs which have been laid. As a large proportion of the plums which have been "stung" by the curculios drop early, and as these grubs are readily eaten by fowls, it is advisable to let poultry and also hogs run freely in the orchards, or if this is not practicable, to gather the fallen plums and destroy them twice a day if possible, beginning about a week after the second spraying.

THE PEACH-TREE BORER.

(Sanninoidea exitiosa Say.)

The Peach-tree borer is one of the most serious enemies with which peach growers in this country have to contend. Much attention has recently been paid to this insect and many experiments have been

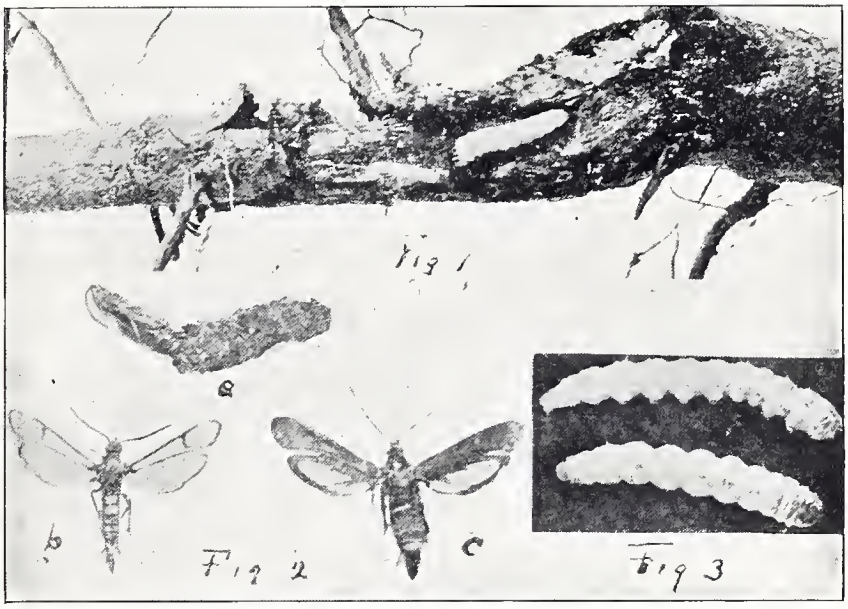

Fig. 8.—Peach Tree Borer. Plum root showing work of borer; 2 a, pupa case; b, male moth; c, female moth; 3, two grubs somewhat enlarged (From *Sirrine.*)

made with a view to protecting the trees from its attacks, the results of which have somewhat changed our ideas as to the best methods to follow.

Life History.

The adult borer is a rather pretty, clear-winged moth, rarely seen by the peach grower. It appears in Pennsylvania early in June and lays its eggs on the bark of the peach tree, preferably near the ground, though they are sometimes placed as far up as the crotches of the lower branches. The egg soon hatches into a little grub which eats its way through the bark to the sapwood where it lives till fall, its feeding causing the production of masses of gum on the bark just outside where the borer is at work. At the approach of winter the grub ceases its work, but resumes operations again the following spring, and feeds until about the last of May or until it is full grown, when it is about an inch long. It then forms a quiet

pupa which changes to the adult moth and leaves the tree early in June to lay its eggs for the next generation.

Treatment.

More than twenty different methods of treatment for this insect have been tested at different times, most of them proving of little value. Only those which have given the best results are considered here.

Mounding.—This treatment seems to be quite effective, keeping out "from one-half to seven-tenths of the borers." The earth should be mounded up around the trunk of the tree to the height of a foot or more, about the first of June, and should remain there till about the last of August, each year.

Paper Protectors.—These may be either of tarred paper or of several thicknesses of newspaper. The paper should be closely wrapped around the trunk, the lower edge of the wrapping being covered by the earth, and the upper edge being at least fifteen inches from the ground. The times of applying and removing the wrapping should be the same as for mounding.

Cutting Out.—This treatment is of course remedial rather than preventive and should be used together with the other methods given. It is desirable to cut out the borers in the fall before they have done much damage, but they are so small at that time that many are always overlooked, and it is therefore better practice to do this work about the first of May when the borers are large enough to be easily found. If cutting out each spring be followed by mounding or by wrapping the trunks as already explained, much of the loss by the attacks of the peach-tree borer can be prevented.

THE PEACH-TWIG BORER.

(Anarsia lineatella Zell.)

This insect is very abundant in Pennsylvania and does much damage though its presence is in most cases unknown to the peach grower, who, for this reason, is not aware of his loss from the attacks of this tiny moth.

Life History.

The little caterpillars of the peach-twig borer pass the winter in the spongy bark, chiefly of the smaller crotches of the tree, in small cavities they hollow out and which are marked by small masses of

mixed bark and excrement projecting from the openings of the cavities. In the spring the caterpillars leave these cavities and pass to the leaf buds which they bore into, following along in the stem bearing the bud, eating its substance and causing the leaves to wilt and die. At this time their presence may be discovered by looking for the wilted tufts of leaves which are very noticeable among the others not thus affected. After boring out one shoot the caterpillar passes to another which it destroys in the same way, and it may attack several before becoming full grown. When the caterpillar has reached full size, it forms a small web either in withered leaves on the tree, in leaves or rubbish around the tree, or it may lie exposed on the bark. In either case it now remains quiet for a week or ten days, at the end of which time the internal changes necessary having been completed, the adult moth appears and lays eggs for a new brood. The caterpillars which hatch from these eggs attack new growth of the tree, entering the young twigs where these give off leaves, or sometimes entering the stems of the young fruit, and later, in some cases, boring into the fruit itself. This history is probably repeated by the next brood, and in the fall the eggs for the third brood are probably laid on the bark and the little caterpillars burrow into the bark to pass the winter. There are therefore three broods each year.

Injuries.

The spring brood which passes the winter in cavities in the bark at the crotches, is the one which is most noticeably injurious. As it bores into shoot after shoot in the spring, the number of these which are killed when the insect is abundant is very great, often several hundred of the young shoots on a single tree being destroyed. The result of this upon the tree is to make it scraggy and irregular and to cause it to expend its energy in the formation of new growth at a time when this energy should be devoted to the production of fruit.

Treatment.

The best method of control for this insect which has as yet been found, is to spray the trees in winter to destroy the caterpillars which are then in cavities in the bark at the crotches.

To successfully carry out this method it is advisable to lightly scrape the larger crotches with some blunt edged instrument—a hoe has been found to be well adapted to this purpose. After scraping in this way the tree should be sprayed with kerosene emulsion, made and applied as follows:

Kerosene,	2	gallons.
Whale-oil soap,	½	pound.
Water,	1	gallon.

"The soap, first finely divided, is dissolved in the water by boiling and immediately added boiling hot away from the fire to the kerosene. The whole mixture is then agitated violently while hot, by being pumped back upon itself with a large force pump and direct discharge nozzzle throwing a strong stream, preferably one-eighth inch in diameter. After from three to five minutes pumping the emulsion should be perfect and the mixture will have increased from one-third to one-half in bulk and assumed the consistency of cream. Well made, this emulsion will keep indefinitely, and should be diluted only as wanted for use." To use it, add six gallons of water to a gallon of the emulsion or at that rate. If hard water must be used either in making or in diluting the emulsion for use, add about one-quarter more soap. Spray long enough to thoroughly wet the bark, but not long enough to let the emulsion stand in the crotches in little pools as this would have an injurious effect upon the tree.

PLANT LICE.

(Aphididae.)

Plant lice or Aphids are always an important pest to crops and to flowers as well. They appear early in the spring, often before the plants they feed upon have made a good start, and as they multiply with great rapidity, sometimes cause much loss.

Nearly every plant, shrub and tree has one or more kinds of plant lice which attack it, and in seasons favorable to their rapid increase may so check growth as to seriously injure the crop.

Among the most important plant lice with which the farmer and fruit grower come in contact are the wooly apple louse, often present along scars on apple limbs in the fall, and very noticeable because of the white wooly threads it produces; the green apple louse, often so abundant in spring on the leaves; the black louse on the plum; the wheat Aphis; the pea-vine louse; the cabbage louse; the currant louse; the rose louse and the corn Aphis.

In many cases the first evidence of the presence of plant lice is the curling of the leaves which is often particularly noticeable on cherry and plum trees in May. Often, however, the plant lice are not seen in large numbers till later, in the summer or even fall.

Life History.

No accurate description of the life history of plant lice in general can be given, as different species of these insects have different histories. A few general facts, however, will apply to nearly all.

In a general way it may be stated that plant lice pass the winter

in the egg state, and hatch about the time the buds open in the spring. Each is then a tiny insect with six legs and no wings, which crawls about and sucks the sap from the plant on which it is by means of a sharp-pointed beak which it thrusts through the bark or epidermis of the plant till it reaches the sap. In the course of a few days it becomes adult and begins to produce young, giving birth to three or four a day. These young also become adult in a few days and in their turn produce young, and in this way there may be many generations during the summer. Some one or more of these generations will develop wings and pass to the other plants, thus distributing the insects over the region. In the fall some generation instead of giving birth to young, will lay eggs, and these will winter over and hatch the following spring.

Treatment.

As plant lice are sucking insects, no stomach poison such as Paris green or arsenate of lead is of any value to destroy them, and kerosene emulsion is the most effective remedy made use of. In order to kill the lice, however, every insect must be touched by the oil and this requires careful and thorough spraying. As the lice are usually on the under surface of the leaves the spray must be thrown upward against the lice, and after the leaves begin to curl this is very difficult if not impossible. It is necessary, therefore, that the trees should be carefully watched, and be sprayed as soon as the lice appear, and before they have become so abundant as to cause the leaves to begin to curl.

In places where it can be obtained, a strong stream of cold water thrown through a hose upon a tree infested with plant lice, is very effective as it knocks the lice off the tree and kills nearly all of them, but too often this treatment is not available.

In the case of the pea-vine louse, the peas grow in such a way that it is difficult to reach the lice by spraying, and here the best practice is to follow along the rows on a hot day with a branch from some evergreen tree, or a piece of brush, and switch the lice off the vines onto the ground, which can be easily and rapidly done. A cultivator should then follow along the rows and loosening the dry, hot soil, the lice will be dried up by it and die before they are able to return to the plants from which they had been switched off.

SPRAYING MATERIALS.

The chief materials for spraying here suggested are Paris green, arsenate of lead and kerosene emulsion. It is well to speak more fully of these substances as one-half of the value of spraying depends upon whether they are properly made or not, while the other half is determined by when and how they are applied. Combinations of insecticides and fungicides are also important for if these can be applied together rather than separately much time and labor can be saved. A short consideration of these points, therefore, should be of value.

Paris Green.

This insecticide which has been used in quantities for the destruction of insects longer than any other, is a chemical combination of arsenic, copper and acetic acid. The arsenic (arsenious oxide) is of course the poisonous substance, and a good Paris green should contain over fifty per cent. of it. Much that is on the market, however, contains less than this amount, and is known as "Low grade Paris green," and is worth less for use than the higher grades (though it is generally sold at about the same price as the better article), as the farmer who uses it is putting less poison on his crops than he supposes.

In some States, laws have been enacted requiring that all Paris green sold should contain at least fifty per cent. of arsenic—a law that has frequently done more harm than good—and in order to comply with it, manufacturers sometimes produce a low grade article, and during its manufacture or afterwards, add enough arsenic to bring the percentage of this substance up to that required by the law. But the arsenic thus added does not chemically combine with the other substances present in the Paris green, but remains as free arsenic which burns the leaves badly as everyone who has used much Paris green knows. In this way a poor quality of Paris green which would cause little or no burning of the foliage, becomes, by the addition of the free arsenic, a dangerous substance to apply to leaves of any kind.

Another objection to Paris green is that it is frequently adulterated with other substances, such as flour or plaster. Though such adulterations do no harm when applied to foliage, the purchase of such Paris green is much more expensive than it would be to buy these materials separately and mix them.

A further objection to Paris green is that some of the arsenic ac-

tually combined with the copper and acetic acid appears to dissolve in water in the spraying tank, and in this way even a reliable article may sometimes cause burning.

Finally, Paris green when mixed with water is quite heavy and tends to settle to the bottom of the tank, and though all good spray pumps are provided with an automatic agitator, the amount of the poison sent out when the tank is full and when it is nearly empty will differ considerably and the results will be correspondingly unreliable.

For these reasons Paris green is less favorably looked upon as an insecticide than was once the case, and other materials are being more used each year in its place.

Arsenate of Lead.

This substance is a chemical combination of arsenic and lead, and as the arsenic in it is all combined, no burning from its use results, no matter how strong it is made. It is therefore safe to use on all kinds of trees.

It is lighter than Paris green, needing little stirring to keep it from settling, and it adheres to the leaves a much longer time, it generally being necessary to spray but twice with it where three times would be needed with Paris green. Thus, though it costs a little more, this cost is more than an off-set by the reduction in number of treatments necessary.

It is made as follows:

Arsenate of soda (50 per cent. strength),..	4 ounces.
Acetate of lead, ...	11 ounces.
Water, ...	150 gallons.

Put the arsenate of soda in two quarts of water in a wooden pail, and the acetate of lead in four quarts of water in another pail, also of wood. When the chemicals are all dissolved, pour the contents of both pails into the spraying tank with the rest of the water, and stir for a few minutes before using.

Those who prefer to make use of arsenate of lead ready prepared can obtain it from the Bowker Insecticide Company, 43 Chatham street, Boston, Mass., by whom it is sold under the name of Disparene, or from several other firms which supply this article.

Kerosene Emulsion.

Paris green and arsenate of lead are termed stomach poisons, and are used for insects which bite off and swallow solid food. Kerosene emulsion is a contact poison and is used for those insects which suck the juices from plants and which cannot therefore be destroyed by stomach poisons.

Where a contact poison is used it is necessary to touch each insect with a drop of the spray in order to destroy it, while a stomach poison may be spread upon the leaves for the insect to eat with its food at any time it may happen to reach it. Spraying with contact poisons is, therefore, much more difficult than with stomach poisons.

Kerosene emulsion is usually made as follows:

Hard soap, shaved fine, ...	½ pound.
Water, ...	1 gallon.
Kerosene, ...	2 gallons.

Dissolve the soap in the boiling water; remove it from the fire and pour it into the kerosene while hot. Churn this with a hand spray pump until it changes to a creamy, then to a soft butter-like mass. This may be used as a stock, and should keep for some time. For use, take one part of the stock and nine parts of water for plant lice, though where the insects to be treated have harder bodies, one part of the stock to four or five parts of water can be used to advantage.

Insecticides and Fungicides.

It is important to spray fruit trees before they blossom, with Bordeaux mixture to destroy fungous diseases, and as this is also the time to spray for many insects it is often desired to use the insecticide and fungicide together. This can be easily done, the Bordeaux mixture combining well, both with Paris green and arsenate of lead, and the following directions give the best methods for preparing these combined sprays:

Bordeaux Mixture and Paris Green.

Bordeaux mixture, ...	50 gallons.
Paris green, ...	4 ounces.

Stir the two till well mixed before using.

Bordeaux Mixture and Arsenate of Lead.

Prepare the arsenate of lead as already directed, but instead of adding the two chemicals when dissolved, to the rest of the water in the spraying tank, add them to fifty gallons of the Bordeaux mixture placed in the tank and stir for a few minutes before using.